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PSYCHE

VOL. XLV DECEMBER, 1938 No. 4

ARE ANT LARVÆ APODOUS?

BY GEORGE C. WHEELER

University of North Dakota

Imms[1] states that "in all the higher Hymenoptera the prevalent larval type is apodous." Practically, of course, this is true of ant larvæ. But what is one to say of the pairs of small structures found near the posterior border of the ventral surface of each thoracic segment?

A study of the larvæ of some four hundred species of ants in 130 genera representing all of the subfamilies has convinced me such structures are of general occurrence throughout the Family Formicidæ. They are to be found in the subfamilies Dorylinæ, Cerapachyinæ, Ponerinæ, Myrmicinæ, Dolichoderinæ, and Formicinæ. I have not found them in the Pseudomyrminæ, but this may be due to the fact that the ventral surface of the thorax is so complicated by exudatoria and by the trophothylax that a small linear structure might easily be concealed or confused with a wrinkle in preserved material. The solution of the problem requires living specimens. I have not searched for the structures in the Leptanillinæ, partly because the larvæ are so minute and partly because my material is so scarce that I dare not risk any of it at this stage of my study of ant larvæ.

In the literature on ant larvæ I have found no mention of these structures. Imms[1] says that "vestiges, in the form of papillæ, of what appear to be the remains of thoracic appendages have been detected in Polysphincta and certain other

---

[1] Imms, A. D. 1937. Recent advances in entomology (2 ed.). Philadelphia: P. Blakiston's Son and Company, Inc., p. 60.

of the Ichneumonoidea." Keilin[2] has found comparable structures on the apterous larvæ of many families of Diptera. He calls them *organes sensoriels vestigiaux des pattes.* They are always in the same position on the thoracic segments and they always consist of three or four sensory hairs, which are sometimes mounted on small protuberances. Keilin concludes that they are vestigial legs because of their general occurrence throughout the Diptera; because of the constancy of their form and constitution; because they are found exclusively on the ventral surface of the thoracic segments; and finally because of their relations to the imaginal buds. This conclusion is in accord with that of Pérez.[3]

Among the ant larvæ these leg vestiges attain their maximum size in the army ants (Dorylinæ). In the genera Dorylus, Eciton, and Cheliomyrmex they are relatively large, subcircular, convex, slightly elevated papillæ. In the mature larvæ of *Eciton hamatum* (Fabr.) (Fig. 1) and *Dorylus* (*Anomma*) *wilverthi* Emery the diameter of the papilla is 0.05 mm. This is also the size in both young (?) larva (2.8 mm. long) and a mature larva (5 mm. long) of *Cheliomyrmex megalonyx* Wheeler. I can find nothing to suggest a sensory function. In *E. hamatum* the surface of the papilla is roughened, but in the other two species it is apparently quite smooth. The close relationship between vestigal legs and imaginal buds is shown in Figs. 2, 3, and 5. In some genera of other subfamilies the vestiges are small transversely elliptical papillæ, but more commonly they appear merely as short transverse lines (grooves or ridges?) which are often difficult to find (Fig. 11). In some genera I have found no trace of the vestiges (*e.g.*, *Eusphinctus steinheili* Forel and *Lioponera luzuriagae* Wheeler & Chapman).

It is not surprising that these vestigial legs have been overlooked in ant larvæ, for in addition to being minute and inconspicuous (except in the Dorylinæ), it is very difficult to distinguish them except in exoskeletons cleaned with a solution of potassium hydroxide and stained with acid fuchsin.

In addition to the vestigial legs I have found some other puzzling structures in ant larvæ. On the mesothorax and metathorax there are small paired structures—probably grooves—located one on each side approximately midway between the leg vestige and the spiracle, *i.e.*, ventrolateral and therefore in close proximity to the imaginal buds of the wings. These can hardly be termed wing vestiges since there is no reason for assuming that the ancestral larva had functional wings. They may, however, be the vestiges of wing pads of the nymph of a heterometabolous ancestor. Finally, they may be prothetelous, *i.e.*, adult structures appearing prematurely in the larva. I shall call them provisionally "wing rudiments."

---

[2] Keilin, D. 1915. Bull. Soc. France Belgique. 49: 166-173.

[3] Pérez, C. 1911. C. R. Soc. Biol., Paris. 71: 498-501.

In the male larva of the army ant, *Eciton* (*Acamatus*) *schmitti* Emery (Fig. 4), these wing rudiments appear as short transverse lines (grooves?). They are not present in the worker larva of the same species nor are they to be found in the worker larva of *E. hamatum.* A larva of the Australian bulldog ant, *Myrmecia gulosa* Fabr. has short (0.045 mm.) transverse lines (slits?). Similar structures occur in both worker and male larvæ of *Cephalotes atratus* (L.) and also in the larvæ of *Dorymyrmex pyramicus* var. *flavus* McCook. In the sexual larva of *Dolichoderus* (*Hypoclinea*) *taschenbergi* Mayr the wing rudiments have a complicated internal cuticular structure. I can find no evidence of such structures in *Cerapachys* sp., *Paraponera clavata* Fabr., or *Melophorus bagoti* Lubbock.

There is also to be found among ant larvæ a third type of related structure, namely vestigial gonopods. I have so designated them because typically they are paired and located on the ventral surface of the seventh, eighth, and ninth abdominal segments and only on those segments. Gonopods are generally asserted to be the modified appendages of the eighth, ninth, and tenth abdominal segments, but in the larva of *Eciton hamatum* (Fig. 1) the gonopodal imaginal discs are to be found on the seventh, eighth, and ninth.

As a rule these vestigial larval gonopods are short transverse lines (slits?). Frequently the members of a pair are fused to form a single median line. In *Pseudomyrma arboris-sanctæ symbiotica* var. *lœwensohni* Forel, however, they are subelliptical papillæ. In some species one or more pairs are apparently lacking, *e.g.*, that of the seventh in

Melophorus bagoti and that of the ninth in *Pseudomyrma lœwensohni;* in the male larva of *Eciton* (*A.*) *schmitti* there is none on the seventh and eighth and only a very faint trace on the ninth; in *Eusphinctus steinheili* there is none at all.

It is interesting to note here that these same structures also occur in other aculeate Hymenoptera. Three pairs of vestigial legs, two pairs of wing rudiments, and three pairs of vestigial gonopods (on the seventh, eighth, and ninth abdominal segments) are present in the larvae of the hornet, *Vespula* (*Dolichovespula*) *maculata* (L.); of the yellow jackets, *Vespula* (*V.*) *maculifrons* (R. du Buysson) and *V.* (*V.*) *arenaria* (Fabr.); of the wasp, *Polistes pallipes* LePeletier (Fig. 8); and of an undetermined mud dauber (Sphecidæ). I have, however, been unable to find any such structures in the worker honeybee, in the drone honeybee, nor in an undetermined bumblebee.

The leg vestiges in *Vespula arenaria* (Fig. 7) are open transverse grooves, which fact of itself suggests a possible sensory function. Furthermore one of my sections shows a structure (Fig. 9), which might be nervous, extending from the bottom of this groove to the hypodermis. A section of a gonopodal imaginal disc reveals in the overlying integument a small sensilliform structure (Fig. 6).

Four possible interpretations of these structures have occurred to me. (1) All three types are vestiges: vestigial legs on the three thoracic segments; vestigial abdominal legs (gonopods) on the seventh, eighth, and ninth abdominal segments; and vestigial wing pads on mesothorax and metathorax. (2) All three types are rudiments of adult structures appearing prematurely in these holometabolous larvæ. (3) The six pairs of ventral structures are vestiges, while the two pairs limited to the mesothorax and metathorax are prothetelous rudiments. (4) All are the results of purely developmental processes and limited to the cuticula at the points where the hypodermis first invaginates to form the imaginal buds. Personally I am inclined to prefer the third interpretation.

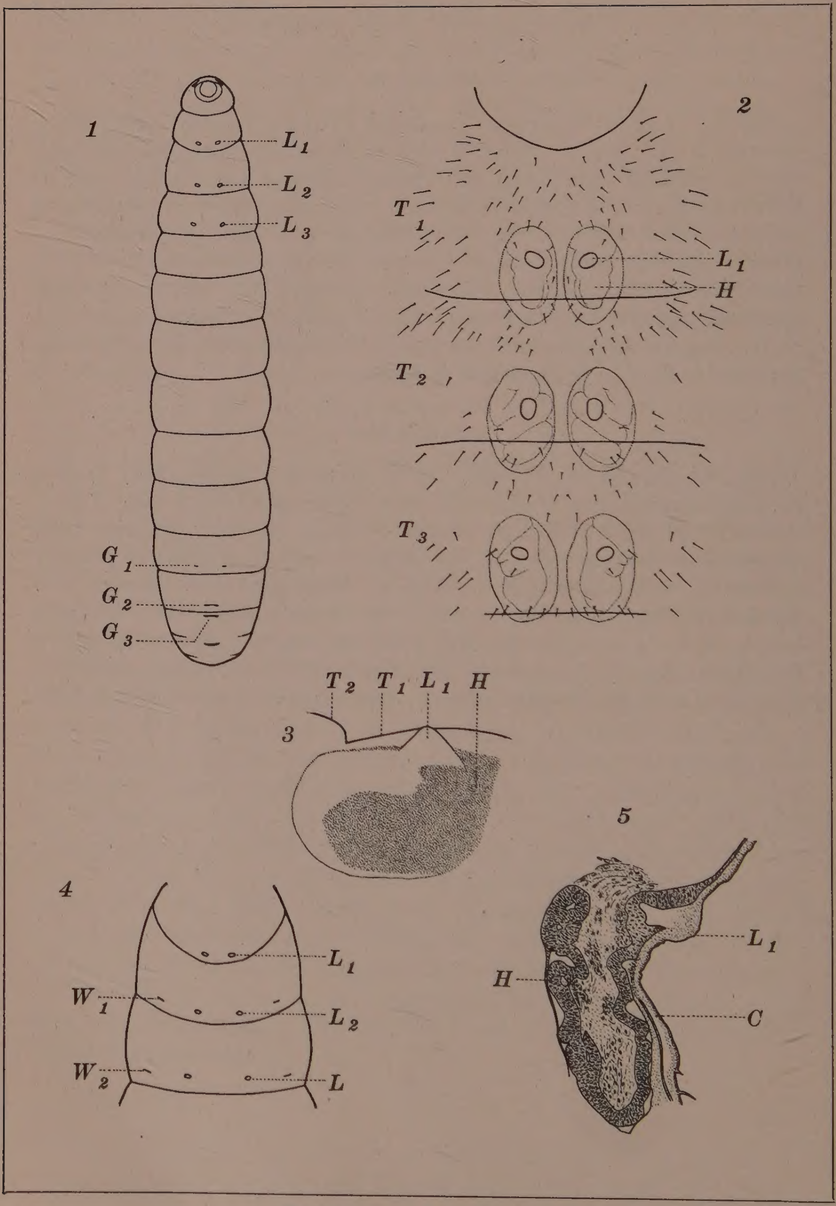
EXPLANATION OF PLATES

PLATE 15

Fig. 1. Larva of *Eciton hamatum* (Fabr.), ventral view, hairs omitted, X 11. Fig. 2. Ventral view of thorax of same showing relation of vestigial legs to the underlying imaginal buds, X 42. Fig. 3. Parasagittal optical section of same to show relation of vestigial leg to imaginal bud, X 135. Fig. 4. Male larva of *Eciton* (*Acamatus*) *schmitti* Emery, ventral view of thorax, hairs omitted, X 11. Fig. 5. Larva of *Eciton vagans* (Olivier), parasagittal section through imaginal bud and vestigial leg, X 95. T_1, T_2, T_3, thoracic segments; L_1, L_2, L_3, vestigial legs; C, cuticula; H, hypodermis; W_1, W_2, wing rudiments; G_1, G_2, G_3, vestigial gonopods.

PLATE 16

Fig. 6. Larva of *Vespula* (*V.*) *arenaria*, parasagittal section through imaginal bud of gonopod, showing sensilla (S), X 138. Fig. 7. Parasagittal section through thorax of same, showing imaginal buds of legs and vestigial legs, X 34. Fig. 8. Larva of *Polistes pallipes* LePeletier, ventral view, X 6. Fig. 9. Enlargement of mesothoracic portion of Fig. 7, showing nerve (?) to vestigial leg, X 138. Fig. 10. Larva of *Pseudomyrma gracilis* (Fabr.), ventral view of posterior end, X 34; A_7, A_8, A_9, seventh, eighth, and ninth abdominal segments. Fig. 11. Larva of *Dilobocondyla* sp., ventral view of anterior end, X 27.



WHEELER — ANT LARVÆ

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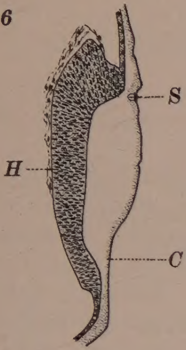

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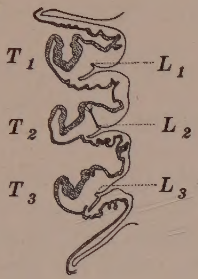

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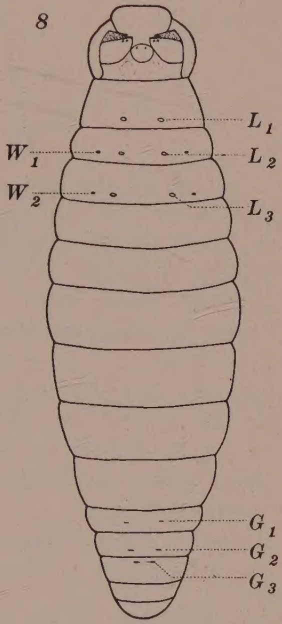

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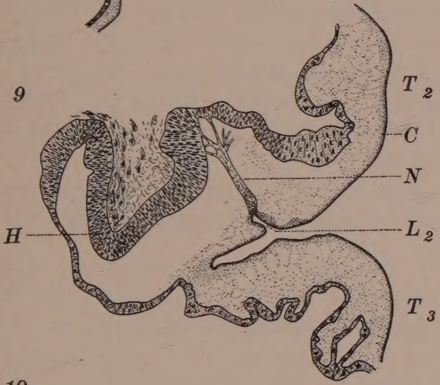

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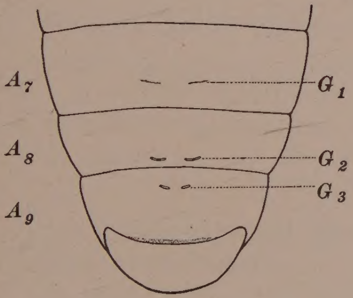

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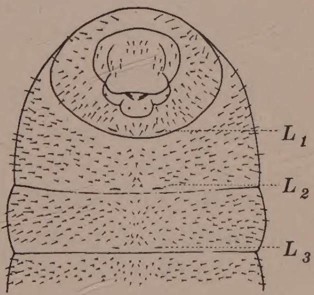

WHEELER — ANT LARVÆ

THE GENUS LITHURGUS (HYMENOPTERA: MEGACHILIDÆ)[1]

BY THEODORE B. MITCHELL

North Carolina State College

Although the genus *Lithurgus* is widely distributed over the earth, the number of species it includes is small, and in no part of the world is there any great number of them known to occur. In North America there are four distinct species, while from all Central and South America only about fourteen species have been described. Since the group is so limited, it is only rarely that new forms are discovered, and the few that are known have not as yet been keyed out in the literature. This paper is a brief summary of the genus in North America, together with a few records and descriptions from other regions.

The following key separates the known Nearctic species together with an apparently new species from an island off the west coast of Mexico

1. Females (only six abdominal terga visible, the sixth entirely hidden by extremely dense pubescence) ......2.
   Males (seven abdominal terga visible, the apical terga visible through the relatively thin pubescence) ....7.
2. Facial protuberance much narrower than width of face ....3.
   Facial protuberance almost as broad as face ....5.
3. Facial protuberance entire, protruding uniformly for its entire width, slightly bowed .... *gibbosus* Smith
   Facial protuberance not entire ....4.
4. Margin of prothorax dorsally conspicuously fasciate; scopa white .... *echinocacti* Cockerell

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[1] Research Contribution No. 2 published with the aid of the State College Research Fund, Department of Zoology, North Carolina State College of Agriculture and Engineering of the University of North Carolina.

Margin of prothorax only very thinly fasciate; scopa yellowish-orange .... *socorroensis* new species

5. Pubescence at tip of abdomen bright ferruginous .... *apicalis* Cresson

Pubescence at tip of abdomen black ....6.

6. Apical margin of clypeus with a single median emargination; scopa without black hairs .... *apicalis* var. *opuntiae* Cockerell[2]

Apical margin of clypeus with a small median emargination and a slightly deeper one on each side; scopa on sixth sternum black, with a few black hairs usually on the fifth also .... *bruesi* Mitchell

7. Clypeus and supraclypeal area quite densely rugose or punctate ....8.

At least the supraclypeal area shining and very sparsely punctate ....9.

8. Labrum with a prominent basal tubercle visible just above mandibles .... *gibbosus* Smith

Labrum not tuberculate .... *echinocacti* Cockerell

9. Labrum with a pair of conspicuous parallel spines toward the base .... *bruesi* Mitchell

Labrum with a single median tubercle or none ....10.

10. Labrum with a basal median spine-like acute tubercle; supraclypeal area almost impunctate, the clypeus quite closely punctate .... *socorroensis* new species

Labrum not tuberculate; supraclypeal area with sparse scattered punctures, the clypeus also sparsely punctate medially ....11.

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[2] *L. arizonensis* ♀ Cockerell has been described recently (Bull. So. Calif. Ac. Sc. 36, p. 108, 1938), but I was unaware of it at the time this manuscript was prepared. According to its description, it would run in this key to *opuntiae*, and is apparently very closely allied to it. Cockerell separates it from *opuntiae* ♀ by its more flattened clypeus, having larger punctures, and the facial punctures deeper and more widely separated. It seems probable that it is another variant of *apicalis*, but I am not warranted in forming any positive opinion until I have had the opportunity of examining it, and of examining a longer series of var. *opuntiae* than has hitherto been possible.

11. Pubescence at tip of abdomen rather dark ferruginous or fuscous .... *apicalis* var. *opuntiae* Cockerell

Pubescence at tip of abdomen light ferruginous .... *apicalis* Cresson

Lithurgus apicalis Cresson

Lithurgus apicalis Cresson, Wheeler's Rep. Geogr. Expl. W. 100th Merid., p. 724, 1876. Cresson, Proc. Dav. Ac. 1, p. 209, 1876. Cockerell, Bull. Univ. N. Mex. 1, p. 64, 1898. Cockerell, Am. Nat. 34, p. 488, 1900. Cockerell, Ann. Mag. Nat. Hist. (7) 14, p. 24, 1904. Cockerell, Ann. Mag. Nat. Hist. (7) 17, p. 306, 1926. Cockerell, Am. Mus. Nov. 697, p. 13, 1934.

Lithurgopsis apicalis Fox, Ent. News 13, p. 139, 1902.

This species may be quickly recognized among the Nearctic species, by the conspicuous bright ferruginous pubescence at the tip of the abdomen.

ARIZONA: 1 ♂, no locality record. Recorded from Santa Rita Mts. (July) and Temez Mts.

CALIFORNIA: 1 ♀, Laguna, San Diego County, June 21, 1926 (W. S. Wright). 1 ♀, Mammoth, July 8 (or Aug. 7?), 1933.

COLORADO: 4 ♂, 3 ♀, no locality record. 1 ♂, Boulder, June 13, 1933 (M. T. James). 1 ♀, Buena Vista, July 6, 1937, (L. Lanham). 1 ♀, Las Animas, June 21, 1931. 1 ♂, Paonia, Delta County, June 14, 1926 (E. C. Van Dyke.) 1 ♀, Trinidad, June 13, 1899. 1 ♂, 1 ♀, White Rocks, Valmont, July 2 and 4, 1933 and May 30, 1934 (M. & H. James). Recorded also from Chimney Gulch, Fort Garland, Glenwood Springs, Mesa Verde, Ridgeway and Ute Creek.

NEVADA: 1 ♀, Mt. Charleston, 7500 ft., Aug. 13, 1931, (E. E. Tinkham).

NEW MEXICO: 2 ♀, Alamogordo, May 5 and June 9, 1902. 1 ♂, Highrolls, June 2, 1902. 1 ♂, E. Las Vegas, June 24, 1902. 5 ♂, 7 ♀, San Antonio, June 1921. 1 ♀, San Jose, Apr. 13, 1934, (M. & H. James). 1 ♂, Santa Fe, July 24, 1926 (E. C. Van Dyke).

TEXAS: 1 ♂, no locality record.

WYOMING: 1 ♀, Lake Bamforth, June 24, 1934 (R. O. & V. D. Christenson). Recorded also from Green River (July), Laramie River and Sheridan (Aug., on *Carduus*).

Specimens of *apicalis* have also been recorded from Kansas—Hamilton County; Nebraska—War Bonnet Canyon (June); and South Dakota—Custer.

Lithurgus apicalis var. **opuntiæ** Cockerell

Lithurgus apicalis opuntiæ Cockerell, Ent. News 13, p. 182, 1902. Cockerell, Proc. U.S.N.M. 40, p. 251, 1911. Cockerell, Ann. Mag. Nat. Hist. (8) 13, p. 433, 1914.

There is no evident structural difference between this form and typical *apicalis*, the chief difference being one of color. It bears a close resemblance to *L. bruesi*, the females especially of the two being very similar. The presence of a single median emargination on the apical margin of the clypeus seems to be a constant character which will distinguish it from the female of *bruesi* in which there are three emarginations. The simple labrum of the male will easily distinguish it from *bruesi* in which that part is bispinose basally.

ARIZONA: 1 ♀, no locality record. 1 ♂, Kits Peak, Rincon, Baboquivari Mts., Aug. 1-4, 1916. 1 ♂, 1 ♀, S. Rita Mts., 5-7 and 12-6. Recorded also from Fort Grant.

CALIFORNIA: 1 ♂, Andrews Canyon, Apr. 5, 1925, (Timberlake, on *Opuntia*) [Timberlake].

COLORADO: 2 ♂, White Rocks, Valmont, May 30, 1934.

MEXICO: 1 ♂, 1 ♀, N. Sonora (Morrison) [Brit. Mus.].

TEXAS: Recorded from Valentine.

Lithurgus apicalis var. **littoralis** W. P. Cockerell

Lithurgus apicalis littoralis W. P. Cockerell, Journ. N. Y. Ent. Soc. 25, p. 191, 1917.

I have had no opportunity to examine this form. It was briefly described from material collected at Point Isabel, near Brownsville, Texas. The size (10 mm.) and the presence of distinct black hair on the discs of the abdominal terga suggest that it is distinct from *apicalis*. I have one small male of *bruesi* which fits the description of *littoralis* fairly well, but as no structural details are mentioned in the description it can only be suggested as possible that the two are the same.

Lithurgus bruesi Mitchell

Lithurgus bruesi Mitchell, Psyche 34, No. 2, p. 104, 1927. Parks, Bull. Brooklyn Ent. Soc. 25, p. 265-7, 1930.

The female of this species was not known at the time that the male was described. Mr. H. B. Parks of San Antonio, Texas, has since collected it in numbers and the following description is based on that material.

Female: — Size: Length, 13-15 mm.; breadth of abdomen, 4.5-5 mm.; anterior wing, 10-11 mm.

Structure: Facial quadrangle about as broad as long; eyes subparallel; facial protuberance broad, evenly incurved, the lateral angles conspicuous; clypeus with shining impunctate apical margin which has a small median emargination and a slightly deeper emargination on each side of the middle; a shining malar space evident, this separated below from cheeks by a quite deep concavity; mandibles obtusely 3-dentate, with a triangular punctate basal area delimited by deep sutures; all the tibiæ with prominent spine-like tubercles, largely confined to a single row on the front pair, but covering the posterior center surfaces of the others.

Puncturation: Punctures sparse and scattered on the relatively dull clypeus, close and rather fine at sides of face, on vertex back of ocelli, and most of cheeks, more coarse and scattered on cheeks below, more widely separated just above eyes; mesonotum and scutellum rather finely rugoso-punctate, the pleura finely and closely punctate above, becoming more coarse and sparse below, the propodeum tessellate, but hardly punctate, the tegulæ impunctate and dull; abdomen impunctate basally, becoming distinctly punctate laterally and apically, the punctures of segment 5 quite deep and conspicuous, quite widely separated medially but close laterally.

Color: Black; antennæ and tegulæ very slightly reddened; wings faintly smoky, the nervures piceous to blackish; spurs brownish-yellow.

Pubescence: Thin and greyish but rather long on vertex, whiter and more dense around antennæ, at sides of face, and on cheeks behind and below, clypeus with an apical fringe which is white laterally but brownish medially; dorsum of thorax almost bare, pubescence laterally and beneath rather long, thin and greyish-white, whitish on legs basally, becoming more brownish apically, blackish on hind tarsi; abdomen basally largely bare above, with very short dark pubescence evident laterally, segment 5 with relatively long conspicuous fuscous pubescence, that on segment 6 fuscous and extremely dense; segments 2-5 with white apical fasciæ, interrupted medially on segments 2-4; scopa yellowish, fuscous to black on segment 6 and with some of the same color on segment 5 across apical margin; sterna 2-5 with entire white apical fasciæ beneath scopa.

9 ♂, 44 ♀, Bexar County (San Antonio), Texas. 1 ♂, Austin, Texas, Apr. 16, 1933 (both H. B. Parks). 1 ♀, Big Bend Park, Brewster Co., Texas, June 17, 1937, (R. H. Baker).

Lithurgus echinocacti Cockerell

Lithurgus echinocacti Cockerell, Ann. Mag. Nat. Hist. (7) 2, p. 453, 1898. Cockerell, Am. Nat. 34, p. 487, 1900. Cockerell, Ann. Mag. Nat. Hist. (9) 8, p. 368, 1921.

Lithurgopsis echinocacti Fox, Ent. News 13, p. 139, 1902.

This species bears some resemblance to *socorroensis* but differs from it in the following characters:

♀ — Prothorax with a distinct and conspicuous white fascia along its posterior margin; polished concavity of facial protuberance with scattered punctures; transverse process of labrum broader and less deeply emarginate.

♂ — Prothorax fasciate as in ♀; supraclypeal area more closely and coarsely punctate; labrum without a basal tubercle.

ARIZONA: 1 ♂, Coyote Mts., Aug. 3-7, 1916, about 3500 ft. [Am. Mus. Nat. Hist.]. Recorded from Palmerlee and Tempe (July and Aug.).

Lithurgus gibbosus Smith

Lithurgus gibbosus Smith, Cat. Hym. Brit. Mus. 1, p. 147, 1853. Cockerell, Am. Nat. 34, p. 487, 1900. Cockerell, Entomologist 33, p. 244, 1900. Cockerell, Ann. Mag. Nat. Hist. (8) 13, p. 433, 1914.

Lithurgus compressus Smith, Cat. Hym. Brit. Mus. 1, p. 147, 1853.

Lithurgopsis gibbosus Fox, Ent. News 13, p. 140, 1902.

This species is the single representative of the genus occurring east of the Mississippi River.

FLORIDA: 1 ♀, Capron, Apr. 18. 2 ♂, Enterprise, Apr. 18, 1902 (Dr. Castle) and Apr. 24, 1903. 2 ♂, 1 ♀, Flamingo, Apr. 13, 1923.

GEORGIA: 1 ♀, St. Simons, June 2, 1922 (Mitchell, on *Opuntia*).

NORTH CAROLINA: 2 ♀, Carolina Beach, June 12, 1930. 1 ♂, Raleigh, June 7, 1922 (on *Opuntia*). 1 ♀, Tarheel, July 22, 1928 (on *Helianthus*). 4 ♀, White Lake, May 20, 1934 (on *Opuntia*); (all Mitchell).

TEXAS: 2 ♂, no locality record, 12 ♂, 20 ♀, Bexar County (San Antonio), May 12 to June 1, 1930 (H. B. Parks). 1 ♂, Fedor, May 1, 1897. Recorded also from Austin and Lee County.

Lithurgus socorroensis new species

Female. — Size: Length 11 mm.; breadth of abdomen 3.7 mm.; anterior wing 7.5 mm.

Structure: Facial quadrangle slightly narrower above than long; eyes convergent below; clypeal margin straight and entire; labrum with a basal transverse process which is abruptly emarginate medially; facial protuberance low, concave, highly polished, somewhat conical on each side; lateral ocelli subequally distant from eyes and edge of vertex; vertex rounded; cheeks subequal in width to eyes; basal joint of flagellum equal to pedicel, the second joint broader but slightly shorter; mandibles 3-dentate, the middle tooth prominent; all the metatarsi slender, the hind pair equalling their tibiæ in length, the others shorter than their respective tibiae; pulvilli inevident; outer posterior faces of all the tibiæ conspicuously tuberculate, the tubercles short and acute, those on the front tibia more robust apically, forming a quite distinct posterior comb apically, those on the middle tibia in two distinct rows, the surface between polished, those on the hind tibia scattered, the surface polished between them; apical margins of abdominal segments slightly depressed, more so toward sides.

Puncturation: Close and fine on face, vertex and on pleura above; coarse and rather sparse on pleura below and on the shining clypeus; cheeks finely and quite closely punctate above, rather coarsely so below; mesonotum rather coarsely striately rugose, especially medially, becoming finely rugose or subpunctate toward prothorax; scutellum rather finely rugose; basal segments of abdomen impunctate medially, becoming rather finely and closely punctate laterally, and the more apical segments quite distinctly punctate, the fifth with moderately coarse and distinctly separated punctures.

Color: Black; tegulæ and wing nervures piceous; antennæ beyond the basal joint of the flagellum ferruginous; wings subhyaline, faintly clouded apically; spurs yellow.

Pubescence: White at sides of face, around antennæ, on cheeks, pleura, propodeum, dorsum of thorax anteriorly, and on legs; white, but thin and inconspicuous on vertex; mesonotum, scutellum and basal abdominal terga almost bare, fifth tergum with scattered erect dark hairs, the apical one with dense fuscous pubescence; second to fifth terga with entire and conspicuous white apical fasciæ; sterna also with narrower but entire white apical fasciæ beneath the reddish or orange scopa.

Male. — Size: Length 10 mm.; breadth of abdomen 3 mm.; anterior wing 7 mm.

Structure: Face with breadth above about equal to length; eyes convergent below; lateral ocelli slightly nearer edge of vertex than to eyes; cheeks subequal in width to eyes; clypeal margin nearly straight, entire; labrum with a basal median conical robust tubercle; supraclypeal area flattened, impunctate medially, polished; basal joint of flagellum subequal to pedicel and to the second joint; mandibles 3-dentate; tibiæ finely tuberculate or rugose on outer faces, the metatarsi slender, shorter than their tibiæ; claws deeply cleft, a small but distinct pulvillus between them; apical margins of abdominal terga slightly depressed, especially toward sides.

Puncturation: Close and fine on vertex and pleura, becoming coarser but close on face and on clypeus; fine and close, but shallow and obscure on cheeks; mesonotum and scutellum finely rugose; punctures minute and rather sparse on fifth tergum, close and more coarse on sixth.

Color: Black; tegulæ and wing nervures reddish-piceous; flagellum ferruginous; wings subhyaline, faintly clouded apically; spurs pale yellow.

Pubescence: White on face, cheeks, pleura, propodeum, legs and basal segment of abdomen; intermixed light and dark on vertex, mesonotum and scutellum; very short and blackish on the second and following segments of abdomen, becoming rather long on the more apical segments, especially on the sixth and seventh, the second to the sixth terga with entire white apical fasciae, the corresponding sterna with very narrow apical fasciae, the discs covered with long thin yellowish scopa-like hairs.

Type. — Female; Braithwaite Bay, Socorro Island, Revillagigedo Group (Mexico), May 7, 1925, (H. H. Keifer) [Calif. Ac. Sc. no. 4602].

Allotype. — Male; topotypical.

Paratypes. — 1 ♀, 21 ♂, topotypical.

Lithurgus corumbæ Cockerell

Lithurgus corumbæ Cockerell, Proc. Ac. Sc. Phil. 53, p. 216, 1901.

The specimen described below bears the same data as the female described by Cockerell under this name and agrees with his description as to size and quite well also as to pattern of pubescence, allowing for sexual differences. There seems little doubt therefore that this specimen represents the other sex of the species.

Male. — Size: Length 7 mm.; breadth of abdomen 2 mm.; anterior wing 5 mm.

Structure: Face narrow, eyes slightly converging below, clypeus flat, the apical margin straight, labrum simple, without spines or tubercles, mandibles short, of the usual 3-dentate type, supraclypeal area with a pair of obscure low tubercles, one below each antenna, lateral ocelli slightly nearer edge of vertex than to eyes, cheeks narrower than eyes, all the tarsi very slender, hind femora short and rather robust, about equalling the combined coxa and trochanter in length, pulvillae absent on all the legs, the claws deeply cleft, seventh tergum forming a nearly equilateral triangle, the apex sharply pointed.

Puncturation: Fine and densely crowded over face, clypeus, and median portion of vertex, more distinctly separated on vertex laterally, very fine and close, but not crowded, on cheeks; deep, close and distinct over most of thorax, but with evident shining spaces between, moderately coarse, becoming quite fine and crowded on sternum; very minute and crowded on median abdominal terga, becoming yet more fine and obscure toward the base, but quite coarse and distinct toward the apex.

Color: Black; mandibular teeth reddened; apical tarsal joints pale ferruginous; spurs pale yellow; tegulae ferruginous; wings subhyaline, the nervures fuscous.

Pubescence: White on head and thorax, but vertex and mesonotum with some very short and inconspicuous reddish pubescence, hind margin of prothorax above with a narrow but distinct white fascia and tubercles fringed with white; second to fourth abdominal terga with white apical fasciæ broadly interrupted medially, the fifth and sixth terga with entire white fasciae, pubescence of the discs black, sterna with longer thin, white pubescence, black on the sixth and on the fifth laterally, no ventral fasciæ evident.

1 ♂, Corumba, Brazil, April. (H. H. Smith) [A. N. S. P.]

Lithurgus albofimbriatus Sichel

6 ♀, Nukahiva, Marquessas Islands, Aug. 1923 (Simeon Delmar).

Lithurgus rubricatus Smith

1 ♀, Bilode, Queensland, Australia, 9. V. 25 (F. G. Holliday). [Univ. Minn.]. 1 ♂, Queensland (Smith coll. pres. by Mrs. Farren White, 99-303) [Brit. Mus.].

NOTES ON NORTH AMERICAN NITIDULIDAE, III: PHENOLIA, SORONIA, LOBIOPA, AMPHOTIS

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Erichson, who erected the genera *Phenolia, Soronia, Lobiopa,* and *Amphotis,* in 1843, had a clearer idea of their relationships than subsequent workers. For instance, Reitter placed *Phenolia,* and *Lobiopa* in *Soronia;* whereas Horn suppressed *Amphotis* as well as *Lobiopa* but resurrected *Phenolia.* Later Sharp and then Grouvelle, without giving reasons, raised them all to the good standing they have had subsequently. Since all of the writers have made mistakes in their diagnoses and since their descriptions have been incomplete, the genera are here redescribed.

1. Front lobed over the insertion of the antennæ .... 2.
   Front not lobed over the insertion of the antennæ .. .. *Phenolia* Er.
2. Antennal grooves parallel .... 3.
   Antennal grooves strongly convergent posteriorly .... *Soronia* Er.
3. Mentum not emarginate anteriorly .... *Lobiopa* Er.
   Mentum emarginate anteriorly .... *Amphotis* Er.

Phenolia Erichson

Phenolia Erichson, 1843, in Germar, Zeitschr. Ent., 4: 299.
Soronia (pars) Reitter, 1873, Syst. Eintheil, Nitid., p. 47.

The front not lobed over the insertion of the antennæ; eye facets about as in *Lobiopa,* coarser than in *Soronia* and *Amphotis;* mandibles bidentate at tip; antennal grooves parallel; labrum feebly bilobed; labial palpi incrassate; mentum distinctly pentagonal; prosternum behind the coxæ expanded and deflexed; elytra feebly costate; epipleuræ extending to apex of elytra but not to the suture; anterior tarsi feebly, middle more feebly, and posterior very feebly dilated.

Phenolia is Nearctic in distribution and contains only one variable species.

Phenolia grossa (Fabricius)

Nitidula grossa Fabricius, 1801, Syst. Eleuth., 1: 347.

This species is found beneath bark and in fungi from Canada and Maine to Wyoming and Texas.

Soronia Erichson

Soronia Erichson, 1843, in Germar, Zeitschr. Ent., 4: 277.

The front lobed over the insertion of the antennæ; eye facets about as in *Amphotis*, finer than in *Lobiopa;* mandibles bifid at tip, the inner cusp slightly proximal to the outer and smaller; antennal grooves strongly convergent posteriorly; labrum feebly bilobed or emarginate, labial palpi filiform, mentum rectangular with small process in center of anterior margin; elytra very feebly costate; epipleurae may extent to the suture; tarsi very feebly dilated; outline more oblong and less oval than in *Lobiopa.*

Although *Soronia* is widely distributed in the Old World, only three species are known from the New World, one each from North America, Brazil, and Mexico to Brazil. Blatchley and Hamilton each described a species from eastern United States. Both species, however, belong in *Lobiopa.*

Soronia guttulata (Leconte)

Lobiopa guttulata Leconte, 1863, Smiths. Misc. Coll., 6: 64.

Leconte described this species from a specimen collected by Ulke in Illinois. In the Leconte collection there is no specimen from Illinois, but there is one from Canada labelled "type" and one each from Marquette, Michigan and Arizona. It has been taken in New York, and specimens from Iowa, Oregon, and California (McCloud, Carrville, and Facht) have been seen. The dates of capture are from April to June 26.

Lobiopa Erichson

Lobiopa Erichson, 1843, in Germar, Zeitschr. Ent., 4: 291.
Cerophorus (pars) Castelnau, 1840, Hist. Nat. Col., 2: 10.
Soronia (pars) Reitter, 1873, Syst. Eintheil. Nitid., p. 46.
Horn, 1879, Trans. Am. Ent. Soc., 7: 306.

Front lobed over the insertion of the antennæ; mandibles bifid at tip, the inner cusp may be smaller than the outer; eye facets about as in *Phenolia*, coarser than in *Soronia;* labrum feebly bilobed; labial palpi more or less incrassate; antennal grooves parallel; mentum rectangular with a small process at center of anterior margin; elytra not costate; epipleurae not extending around apex of elytra; tarsi very feebly dilated.

Lobiopa contains a number of species confined to the New World. In addition to the three species already in the North American list, one is transferred from *Soronia*, three are described as new, and one described as a *Soronia* is synonymized.

1. Six or seven distinct rows of setae on the disc of each elytron .... 2.
About nine distinct rows of setæ on the disc of each elytron .... *setosa* Harold.
2. From above, eyes not as long as pronotal emargination is deep .... 3.
From above, eyes as long or longer than pronotal emargination is deep .... 5.
3. Distinctly less than twice as long as wide .... 4.
Twice as long as wide .... *oblonga* n. sp.
4. Submentum finely punctate, length 3.6-5.3 mm. .... *undulata* (Say).
Submentum coarsely punctate, length 5.3-6.7 mm. .... *falli* n. sp.
5. Above with pubescence, setæ, and coarsely punctate, length more than 4.4 mm. .... 6.
Above nearly glabrous, finely punctate, length 3.5-4.5 mm. .... *brunnescens* Blatch.
6. Lateral margins narrowly explanate .... *punctata* n. sp.
Lateral margins broadly explanate .... *insularis* (Cast.).

Lobiopa setosa Harold

Fig. 5.

Lobiopa setulosa Leconte (non Erichson), 1863, Smiths. Misc. Coll., 4: 63.

Lobiopa setosa Harold, 1868, Col. Hefte, 4: 104.

Soronia undulata (pars) Horn, 1879, Trans. Am. Ent. Soc., 7: 307.

Soronia substriata Hamilton, 1893, Can. Ent., 25: 306.

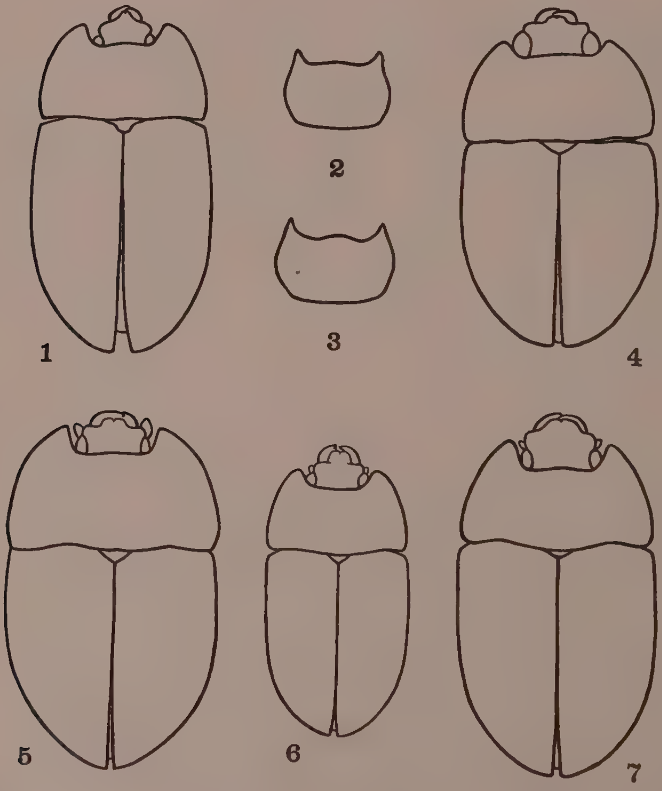
Dr. Hugo Kahl kindly sent me the type of *substriata* Hamilton. After comparison with the type in the Leconte collection, *substriata* turns out to be a synonym of *setosa*. The type of *substriata* is one millimeter longer than Leconte's type, darker above, with slightly more pointed elytra. Since individuals in this genus are very variable, these differences are unimportant. This rare species tends to be broader, more depressed, duller, and darker than its closest relative *undulata*. Specimens have been seen ranging from Massachusetts to Utah, north to Kamloops, B. C., March 21. In Pennsylvania it has been found in May under the bark of maple (*Acer rubrum*).

Lobiopa oblonga new species

Fig. 6.

Length twice the width, oblong oval, feebly convex. Above dull rufo-piceous with faint, irregular, pale maculæ. Margins of thorax and elytra rufo-testaceous. Beneath, including antennæ and legs, dark rufo-testaceous. Head pubescent; closely, finely punctate; very broadly, shallowly impressed between the eyes. The lobes over the insertion of the antennæ more prominent than in all the other North American species except *falli* n. sp. Labial palpi incrassate. Prothorax more emarginate anteriorly than *brunnescens* but less so than the other North American species; with broadly explanate, flatly arcuate lateral margins; hind angles rather broadly rounded; hind margin feebly bisinuate; surface closely finely punctate, finely pubescent, sparsely covered with short pale setæ. Prosternal process relatively more narrow between the coxæ than in the other species. Visible part of scutellum forming an equilateral triangle. Elytra with broadly explanate, feebly arcuate margins; closely, finely punctate; finely pubescent; each elytron with six or seven rows of pale setæ. Beneath closely finely punctate, rather sparsely pubescent. Length of holotype 5.0 mm., width 2.5 mm.; allotype 4.2 mm., width 2.2 mm.

Described from the female holotype, Marble Fork Bridge, 3000-5000 ft., Sequoia National Park, California, June 12, 1929; and male allotype, Upper Soda Spring, Siskiyou



Figs. 1—7. 1, *Amphotis schwarzi* (cotype); 2, mentum of same; 3, mentum of *A. ulkei* (topotype); 4, *Lobiopa punctata* n. sp. (holotype); 5, *L. setosa* (holotype of *substriata*); 6, *L. oblonga* n. sp. (holotype); 7, *L. falli* n. sp. (holotype).

County, California, Aug. 6, 1906, E. N Erhrkom collector; both in the Van Dyke collection of the California Academy of Sciences.

This species, apparently closest to *falli* n. sp., is distinctive in its oblong form. It is less convex than *brunnescens, punctata* n. sp., and *falli* n. sp. but more convex than the other species.

Lobiopa undulata (Say)

Nitidula undulata Say, 1825, Journ. Acad. N. S. Philad., 5: 179.

Soronia undulata Horn, 1879, Trans. Am. Ent. Soc., 7: 307.

Lobiopa undulata Sharp, 1890, Biol. Centr.-Amer. Col., vol. 2, pt. 1, p. 321.

This species varies considerably in color, shape, and size (3.6-5.3 mm.). It is found at sap in the spring and autumn and hibernates beneath logs. The range is Maine and Michigan to Florida, Texas, and "northern Sonora" (Sharp). Sharp's record may refer to the following new species.

Lobiopa falli new species

Fig. 7.

More oval than oblong; feebly convex. Above dull rufo-piceous with the margins of the prothorax and elytra rufo-testaceous. Also there is on the upper surface faint, irregular, pale maculæ, in particular usually a transverse pale band at the posterior third extending half way across each elytron. This band is more evident in *insularis* and *undulata.* Beneath rufo-piceous with the legs paler. Head with a few, thick, erect setæ; pubescent; rather coarsely compactly punctate; alutaceous; with a broad, transverse impression between the eyes; lobes over the insertion of the antennæ very prominent, more so than in the other North American species. Eyes of ordinary size. Labial palpi incrassate. Prothorax as emarginate anteriorly as in *setosa* and *undulata,* more so than in *insularis,* in which the prothorax is more emarginate than in *oblonga* n. sp. Prothorax with lateral margins broadly explanate, evenly and flatly arcuate, narrowing shortly before the acute hind angles;

hind margin distinctly bisinuate; surface closely and rather coarsely punctate, alutaceous, pubescent, sparsely covered with thick setæ. Visible part of the scutellum forming a strongly transverse triangle. Elytra with broadly explanate margins; rather close, coarse, obsolete punctures; alutaceous; finely pubescent; each elytron with about seven rows of thick setæ. Beneath coarsely punctate, sparsely and finely pubescent. Length 5.3-6.7 mm., width 3.1-4.1 mm.

Holotype female, allotype male, and 2 paratypes from Arizona in the Leconte collection, Museum Comp. Zool.; 14 paratypes from 6-7000 ft., Stratton, S. Catalina Mts., July 27, 1917, W. M. Wheeler collector; 1 paratype, Patagonia Mts., Arizona, July 20-Aug. 6, 1930 in the Mus. Comp. Zool. In the U.S.N.M. 25 paratypes from Oracle, Arizona, October 7; 4 paratypes from Palmerlee, Arizona; 7 paratypes from the Santa Rita Mts. and Fort Grant, Arizona. In the University of Kansas collection 4 paratypes from the Chiricahua and Huachuca Mts., July-Aug. One paratype each from Prescott, Arizona, Chisos Mts. and Alpine, Texas, July, in the collection of H. C. Fall. Also 2 paratypes from the Huachuca Mts., 2 paratypes from Oracle, June 7, and 3 paratypes from Globe, Arizona in the collection of the author.

This species varies in outline and in color. In the pale specimens the maculation is most evident, whereas in those that are piceous the maculation is not discernible. The species is distinctive in the prominent lobes over the insertion of the antennae, transverse scutellum, and the unusual covering of thick setæ. It is apparently related to *undulata;* in fact Mr. Fall has specimens of *undulata* from Texas which approach *falli* in the maculation, setæ and lobes over the insertion of the antennæ. But in *falli* the scutellum is more transverse, punctures beneath more coarse, and shape usually more oval.

Lobiopa brunnescens (Blatchley)

Soronia brunnescens Blatchley, 1917, Can. Ent., 49: 238.

This species is definitely a *Lobiopa* and related to *insularis.* The types are from Dunedin, Florida, June 10. In addition there are specimens in the U.S.N.M. from Covington, La., June 13 which differ from the types in showing faint maculation similar to that in *insularis* and slightly coarser punctation of the prothorax. It is remarkable that F. M. Jones collected a specimen Aug. 21, 1931 on Martha's Vineyard, Mass. This specimen, which is in the Boston Soc. Nat. Hist., has no maculation as in the types. Apparently this record cannot be accounted for by hurricanes, since the last one passed over Martha's Vineyard in 1928.

Lobiopa punctata new species

Fig. 4.

Oblong oval, rather strongly convex, shining, rufo-testaceous above and beneath. Head sparsely pubescent, closely, coarsely punctate; broadly impressed between the eyes; lobes over the insertion of the antennæ more transversely produced than in the other North American species; labial palpi incrassate. Prothorax as emarginate in front as *brunnescens*, therefore less emarginate than in the other North American species; lateral margins narrowly explanate and evenly arcuate; hind angles broadly rounded and obtusely angled; hind margin feebly bisinuate; surface closely, coarsely punctate, with sparse pubescence and with sparser small setæ. Prosternal process only slightly reflexed behind the coxæ. Elytra with narrowly explanate, feebly arcuate lateral margins; eight rows of small setæ; finely pubescent; each elytron with two pale spots extending across anterior median agle, a transverse pale band across inner half at posterior third, and center somewhat darker. Beneath closely, coarsely punctate, finely pubescent. Length 5.2-4.5 mm., width 3.1-2.5 mm.

Described from four males; holotype and paratype from Miami, Florida, March 11, 1924 in the collection of H. C. Fall; one paratype from Miami, Florida, March 31 in the Van Dyke collection in the Calif. Acad. of Sciences; and a paratype from Balaclava, Jamaica, A. E. Wright, in the Mus. Comp. Zoology.

This species is apparently closest to *brunnescens*, particularly in the convexity of the body and degree of emargination of the pronotum. It differs from *brunnescens* in its larger size, much coarser punctation and pubescence, narrower lateral margins, and in the prosternal process being only slightly arched longitudinally between the coxæ; whereas in *brunnescens* the prosternal process is strongly arched between the coxæ and reflexed posteriorly.

Amphotis Erichson

Amphotis, Erichson, 1843, in Germar, Zeitschr. Ent., 4: 290.

Soronia (pars) Horn, 1879, Trans. Amer. Ent. Soc., 7: 287.

Front lobed over the insertion of the antennæ; labrum feebly bilobed; mandibles bifid at tip; labial palpi filiform; eye facets about as in *Soronia,* finer than in *Lobiopa;* antennal grooves parallel; mentum emarginate; elytra distinctly costate; epipleurae extend to suture; tarsi feebly dilated.

Amphotis contains two North American and three European species.

Amphotis ulkei Leconte

Fig. 3.

Amphotis ulkei Leconte, 1866, Proc. Ac. N. S. Philad., p. 376.

Soronia ulkei Horn, 1879, Trans. Amer. Ent. Soc., 7: 307.

This species extends from Massachusetts to the District of Columbia in the nests of *Crematogaster lineolata, Formica schaufussi,* and *Formica integra.* It is strictly myrmecophilous in the early spring but in the fall of the year is found in decaying fungi.

Amphotis schwarzi Ulke

Fig. 1, 2.

Amphotis schwarzi Ulke, 1887, Ent. Amer., 3: 77.

Dr. Hugo Kahl of the Carnegie Museum has kindly loaned me the types (collected by Schwarz June 17 at Ft. Monroe, Virginia), all of which are testaceous. Two specimens in the U.S.N.M. from Mobile, Alabama, December 6 are dark testaceous, and a specimen from Southern Pines, N. C., March 3 in the collection of C. A. Frost is rufo-piceous. This species differs from *ulkei* in the additional two costæ on each elytron and in the narrower and less emarginate mentum.

THE INTERRELATIONSHIPS AND LINES OF DESCENT OF LIVING INSECTS

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The lines of descent shown in the accompanying phylogenetic tree should be interpreted as though the figure were a three dimensional one (as is indicated by the basal attachments of the branches of the tree), since the usual method of portraying the lines of descent in the form of a dichotomously branching tree, drawn in one plane, does not bring out the fact that several lines of descent may converge upon a common ancestry, and does not indicate the complicated interrelationships of these lines of descent at all accurately. In fact, sections of cones made up of converging lines would better illustrate the fact that some lines of descent intergrade "horizontally" as well as "vertically," but the method of illustrating the interrelationships of the lines of descent shown in the accompanying figure will serve well enough for all practical purposes, if the figure is interpreted as a three dimensional one.

The hypothetical "Protomalacostraca" shown at the base of the phylogenetic tree, represent the extinct common ancestors of the higher Crustacea (such as the Tanaidacea, Mysidacea, Anaspidacea, etc.) insects and "myriopods". The character of the head, with its sessile eyes, the monocondylar mandibles, with their differentiated incisor and projecting molar regions, the large paragnaths, the slender multiarticulate, cerci-like uropods, and other feature of the Tanaidacea (such as *Tanais, Apseudes, Leptochelia,* etc.) are strikingly suggestive of the precursors of similar structures in the Machiloid insects, and the ancestors of the Tanaidacea (represented by the hypothetical "Prototanaidacea in the diagram) must have been extremely closely related to the more direct ancestors of the Hexapoda (represented in the diagram by the hypothetical "Protohexapoda") and those of the "'Myriopoda" (represented in the diagram by the hypothetical "Protosymphyla" — which would include the direct ancestors of the Chilopoda, Pauropoda, etc., as well as those of the Symphyla themselves).

The hypothetical "Protapterygota," or common ancestors of the Apterygota (and consequently the ultimate ancestors of the Pterygota also), are best represented by the *Machilis*-like Apterygota, although some investigators insist that the Dicellura (such as *Campodea, Anajapyx, Japyx,* etc.), or the Protura, are the most primitive or most "ancestral" insects, despite the fact that the *Machilis*-like Apterygota are morphologically the most primitive (and hence the most "ancestral") of all insects. Some of the features which indicate that *Machilis* (or the family Machilidæ), rather than the Dicellura or other forms, represents the ancestral type better than any other living insect, is indicated by the following facts. (1) *Machilis* has more abdominal limbs (represented by eight pairs of distinct, styli-bearing coxites) than any other insect, including *Campodea* and other Dicellura. (2) The abdominal limbs, or coxites, of *Machilis* project free and distinct from the sternites (and the coxites of the ninth segment are hugely developed), while the abdominal limbs of the Dicellura, for example, are reduced to mere styli-bearing areas scarcely distinguishable from the abdominal sternites with which they have merged — and no other Apterygota have more than three pairs of abdominal limbs. (3) The cerci, or limbs of the eleventh abdominal segment, are larger and better developed than those of any other insect. (4) The terminal abdominal segments of *Machilis* are more distinct, or less fused, than those of the Dicellura, for example. (5) The thoracic terga are better developed and overlap the lateral regions in a more primitive, or Crustaceoid fashion, in *Machilis* (and *Lepisma*), while in other Apterygota the thoracic terga are not of this type. (6) The thoracic limbs are best developed in *Machilis*, and bear styli (epipodites?) in the Machilidae alone. (7) *Machilis* has primitive compound eyes structurally similar to those of Crustacea, and also has well developed ocelli (which likewise occur in certain trilobites, Anaspidacea, etc.), while the Dicellura are eyeless — as is also the case in the Protura (which likewise lack antennae). (8) *Machi-*

lis has preserved the primitive archicephalic or supramandibular suture, characteristic of such Crustacea as *Branchippus, Anaspides,* etc. (9) The huge flagelliform antennæ of *Machilis* are the most like those of trilobites and other primitive arthropods. (10) The huge monocondylar mandibles of *Machilis* are better developed and are more Crustaceoid (with separate incisor and elongated molar regions) than the reduced and highly specialized mandibles of the Dicellura and Protura. (11) The well developed paragnaths (superlinguæ) of *Machilis* are larger and more Crustaceoid than those of other Apterygota. (12) The well developed maxillæ of *Machilis,* with their huge limb-like palpi, are far more primitive than those of any other insects. (13) The lacinial fringes of *Machilis* are more primitively Crustaceoid than those of other insects. (14) The labial palpi etc., of *Machilis* are better developed, and are of a more primitive character than those of other Apterygotan insects. (15) The traces of the second maxillæ forming the under lip are more distinct in *Machilis* than in other Apterygota. (16) The head of *Machilis* is of the ectognathous type, and is much more primitive than the entognathous type (with overgrown mouthparts) found in the Dicellura and Protura, etc.

There are many more features which might be cited to prove that *Machilis* is more primitive or "ancestral" than any other insect, but the facts cited above should be sufficient to convince any impartial investigator that *Machilis* is the most ancestral of all insects. Furthermore, its numerous unmistakably Crustaceoid features clearly prove that *Machilis,* and the other primitive insects descended from similar ancestors, were derived from Crustacea resembling the "Prototanaidacea" in many respects. The well known fact that many Apterygota exhibit striking similarities to various types of "myriopods," merely indicates that both insects and "myriopods" were ultimately descended from the same (Crustacean) ancestry — and the Crustacea are the only intermediate forms serving to connect the insects and "myriopods" with the trilobites and other primitive forms at the base of the common arthropodan stem.

If the Machilidæ are the most primitive or "ancestral" insects, it is obviously misleading to insist that the Dicellura (such as *Campodea, Anajapyx,* etc.) are the most ancestral insects, since they are much more specialized than the Machilidæ. In fact, the Dicellura could readily be derived from a slender blind *Nicoletia* type of Lepismatid Tysanuroid insect (descended from Machilis like forebears) but by no stretch of the imagination could the primitive *Machilis* type of insect be derived from any Dicelluran type — which should be the case if the Dicellura represent the ancestral insects (leading back to some type of "myriopod").

Because they have mouthparts of the concealed type, the Dicellura are sometimes grouped with the Collembola (and Protura) in the division Endognatha, in contradistinction to the Ectognatha, or Thysanuroid forms with mouthparts of the exposed type. The modifications of the mouthparts of the Dicellura, however, are not very similar to the modifications exhibited by the Collembola and Protura; and the Dicellura are only very distantly related to the other "endognathous" Apterygota, while the occurrence of cerci, and styli-bearing coxites, in the Dicellura, allies them more closely with the Thysanuroid Apterygota. It is therefore preferable to unite the Dicellura with the Lepismatidæ (Thysanura) and Machilidae (Protothysanura) in the section *Styligera,* characterized by the occurrence of styli-bearing coxites, and cerci, as opposed to the *Astyligera* (Collembola and Protura), in which these structures are lacking. The Dicellura were possibly derived from some *Niceletia*-like Lepismatid insect, and the Lepismatidæ themselves were apparently derived from ancestors closely allied to the Machilidæ. The Lepismatidæ, in turn, serve to connect the *Machilis*-like ancestors of the Apterygota with the ancestors of the Pterygota, which are best represented by "larval" Ephemerida (which have three caudal filaments like those of Thysanuroid Apterygota), so that the Lepismatid line of development is an extremely important one for the study of the evolution of the higher insects.

The Protura are the most primitive representatives of the section Astyligera, although they have lost the eyes and antennæ, and their mouthparts are rather highly specialized. They differ from the rest of insects by the fact that they exhibit a postembryonic increase in the number of segments (they have nine abdominal segments as "larvae", and eleven as adults) and are sometimes called Anamerentoma, in contradistinction to the rest of insects (called Holomerentoma) which exhibit no such postembryonic increase in segmentation. Their line of development evidently branched off at the base of the Apterygotan stem, and ends blindly, unless it leads to the Collembola.

The line of development of the Collembola is a rather isolated one, but the Collembola resemble the Protura in that they have a ventral head-groove, a postantennal organ, and similarly modified endognathous mouthparts, etc. The Collembolan line of development may have branched off from that of the Protura, although it is also possible that the Collembola represent degenerate offshoots of the primitive Machiloid ancestors of the Apterygota, since the lacinial fringes of such Collembola as *Tetrodontophora* are very like those of certain Machilids. In any case, the line of development of the Collembola is a very isolated one, and has no significance for tracing the lines of descent of other insects.

As was mentioned before, the "larvæ" (naiads) of the Ephemerida, with their *Lepisma*-like terminal filaments (a pair of cerci and an unpaired median terminal filament), and their large paragnaths (superlinguæ), and primitive type of mandibles, provided with a lacinia mobilis like the mandibles of higher Crustacea, etc., are the most archaic representatives of the Pterygota, and suggest that winged insects arose from *Lepisma*-like forebears, which lead back to the Crustaceoid Apterygota such as *Machilis*. "Larval" Ephemerida and Odonata agree in having the lacinia and galea united to form a single lobe in the maxilla, and "larval" Ephemerida and Zygoptera agree in having an unpaired median terminal structure, represented by a gill plate in the Zygopteran naiad, and by a terminal filament in the Ephemerid naiad.

The Ephemerida, Odonata, Megasecoptera and Palæodictyoptera, etc., comprise the division of Pterygota called the *Palæopterygota*, characterized by their inability to lay the wings back along the body in repose. They consequently do not develop a basal fold of the wing, and do not have more than two or three axillary sclerites. Their wings are primitively homonomous, and a neala is not developed in them. The rest of the Pterygota comprise the division *Neopterygota,* characterized by their ability to lay the wings back along the body in repose. They consequently develop a basal fold in the wing, and have more than two or three axillary sclerites. Their wings were originally heteronomous, with an anal fan in the hind wing (though this is lost in many of their descendents), and a neala is developed in the postero-basal region of the wings. This division of the Pterygota is a much more fundamental one than the usual division into Exopterygota and Endopterygota (on the basis of the external or internal development of the wings) which makes an unnatural separation of closely related forms, and lumps together others which are not at all closely related.

The common ancestors of all of these forms are represented in the diagram by the hypothetical "Protopalæodictyoptera". The Palæodictyoptera are the nearest known representatives of these common ancestors, and represent their direct descendents. The Ephemerida were probably derived from the common ancestors of the group by way of the Protephemerida, while the Odonata were derived from them by way of some unknown, extinct forms, to which the Protodonata are very closely related; and the line of descent of the Megasecoptera apparently branched off from the common Palæodictyopteriod stock near the origin of the ancestors of the Odonata. The Odonata are the most "Orthopteroid" of the above-mentioned insects, while the Ephemerida are the most primitive living representatives of the group. The Ephemerida and Protephemerida might be grouped into a superorder called the Panephemeroptera (or Ephemeropteria), characterized by the occurrence of three caudal filaments in many members of the superorder, while the Odonata and Protodonata might be grouped in a second superorder, the Pantyloptera (or Tylopteria) characterized by the skewness of the thorax etc., but too little is known of the morphological details of the fossil forms to enable us to group them correctly at this time.

The Neopterygota may be grouped into three divisions called the Orthopteroid insects (Paurometabola or Orthopteradelphia), the Hemipteroid insects (Parametabola or Hemipteradelphia), and the Neuropteroid insects (Holometabola or Neuropteradelphia); and the Orthopteroid insects represent the ancestral types of the group as nearly as any known forms. The Orthopteriod insects were apparently not derived directly from the Palæodictyoptera, but were probably derived from the Palæodictyopteran stock by way of *Synarmoge* (or *Synarmogoge* as it is sometimes spelled). Since only a fragment of one wing of *Synarmogoge* is known, however, all that can be said concerning it is that it exhibits certain characters intermediate between the Palæodictyoptera and the Protorthoptera.

The Protorthoptera, shown at the base of the lines of descent of the higher insects in the accompanying phylogenetic tree, include the Protoblattids (which have a demarked claval region in the fore wings) as well as the Protorthoptera in the narrower sense (which have no demarked claval area), since the Protoblattids and Protorthoptera merge so indistinguishably that they may be combined into a single ancestral group from which all of the higher insects were ultimately derived. The Protoblattids are the most primitive representatives of the group, and are more like the direct ancestors of the Blattids, Mantids and Isoptera, while the other members of the Protorthoptera are somewhat closer to the direct ancestors of the Orthoptera.

The Orthopteroid insects are characterized by the fact that the cerci are well developed and the parapodial plates (paraprocts) are distinct in all of the members of the group. An anal fan is developed in the hind wings of most of the Orthopteroid insects, but in some of them, such as the Embiida and Isoptera (excepting *Mastotermes*) the wings are secondarily homonomous. The Orthopteroid insects have been grouped into three superorders called the Panorthoptera (or Orthopteria), the Panplecoptera (or Plecopteria), and the Panisoptera (or Isopteria).

The superorder Panisoptera (Isopteria) includes the Palæoptera (Blattids and Mantids) and the Isoptera, and is characterized by the fact that the lateral cervical sclerites are contiguous in the midventral line, the mesothoracic trochantins do not unite basally with the episternum; a claval area is usually demarked in the fore wings, and the seventh abdominal sternite projects below the ovipositor in the members of this superorder. The Blattids have preserved the most primitive venation of any living members of the superorder, while the Isoptera have preserved the various features of the body in as primitive a condition as any members of the superorder. These insects are the most primitive of the Orthopteroid insects, and are practically the direct descendents of the Protoblattid type of Protorthoptera.

The Embiids and Plecoptera are included in a superorder called the Panplecoptera (or Plecopteria), characterized by the fact that the postscutellum of the mesothorax is well developed, and the trochantin of the mesothorax unites basally with the episternum above it, in the members of this superorder. The mesothoracic coxæ tend to become ring-like rather than conical, and the tarsi are trimerous. The eighth and ninth abdominal segments are not greatly narrowed in the females of these insects, which are ovipositorless. The Plecoptera are usually grouped with the Odonata and Ephemerida (rather than with the Embiids among the Orthopteroid insects) but the character of their thoracic sclerites is so strikingly similar, and the venation of the fossil forms intergrades so markedly, that there can be no doubt that the Embiids and Plecoptera are extremely closely related, and were descended from a common Protorthopteran ancestry. The fossil Protoperlaria are rather specialized Plecopteroid insects which branched off at the base of the Plecopteran stem, and the fossil Protembiids apparently branched off at the base of the Embiid stem, but the actual Protorthopteran ancestors from which all of these insects were ultimately derived have not as yet been discovered.

The Orthoptera (including the Grylloblattidæ) and the Cheleutoptera, or Phasmida, and possibly the Dermaptera also (although the closest affinities of the Dermaptera may be with the Blattoid insects comprising the superorder Panisoptera), are included in the superorder Panorthoptera (or Orthopteria), characterized by the huge development of the anal fan, and the consequent reduction of the preanal region of the hind wings. The ovipositor is well developed in most of them, and is overlapped basally by the eighth abdominal sternite (excepting the Dermaptera, which may not belong in this superorder). The male genitalia are usually rather symmetrically developed and the cerci frequently bear mesal prongs, etc., in the members of this superorder.

These insects are the more or less direct descendents of the Protorthoptera in the restricted sense (*i.e.*, the Protorthopteran forms other than the Protoblattids), and their most primitive representatives are the Grylloblattids, which are practically living Protorthoptera, closely related to the Stenopelmatoid Orthoptera (including the *Gryllacris*-types). The latter are connected with the Grylloid Orthoptera by the Prophalangopsidæ (and Tridactyloid types), and are connected with the Acridoidea by the Tettigoniidæ (unless the Tridactyloidea furnish the intermediate forms leading to the Acridoidea).

The Hemipteroid or Psocoid insects comprise the division Hemipteradelphia, or Parametabola, characterized by the development of a mesal detached lacinial structure forming a setiform, or a chisel-like portion of the maxilla (excepting the Zoraptera, which have a normal type of maxilla). The insects belonging to this division may be grouped into two superorders, namely the Panpsocoptera (Psocopteria) including the Psocoptera, Mallophaga and Anoplura, and the Panhemiptera (Hemipteria) including the Hemiptera and Thysanoptera. The lacinial structures are usually chisel-like in the members of the superorder Panpsocoptera, and are setiform in the members of the superorder Panhemiptera.

The Zoraptera are the most primitive representatives of the Hemipteroid insects, and exhibit so many characters suggestive of a close relationship to the Isoptera, that this might be taken to indicate that they and the Hemipteroid insects in general were derived from the same Protorthopteroid ancestry as the Isoptera were. On the other hand, the venation of the Zoraptera shows that they are members of the order Psocoptera, closely related to such Psocids as *Archipsocus* and *Embidopsocus* which exhibit some characters suggestive of a derivation from Embiid-like ancestors; and the Psocoptera in general were probably derived from the common Protorthopteroid ancestors of the Isoptera and Embioptera. The Mallophaga are undoubtedly descended from ancestors extremely closely related to the Psocoptera, and may represent merely degenerate wingless

Psocoptera. The Anoplura were probably derived from ancestors closely allied to the Mallophaga; and all of these insects are sometimes grouped together as Corrodentia, although they are apparently worthy of ordinal rank.

The mouthparts of the Thysanoptera (which have distinct maxillary and labial palpi) are much more primitive than those of the Hemiptera, and it is possible that the Thysanoptera were descended from a slightly more primitive type than the Hemiptera were. At any rate, the Thysanoptera were apparently descended from Protorthopteroid ancestors very closely related to those from which the Hemiptera were derived, and these ancestors evidently resembled the Psocoptera very closely. The Hemiptera were evidently descended from the same Protorthopteroid ancestors from which the Psocoptera were derived, and the Psocoptera have departed the least of any living insects from the types ancestral to the Hemiptera. Not only does the venation of living Psocoptera parallel that of certain Hemiptera-Homoptera strikingly closely, but the venation of certain fossil Hemiptera merges with that of certain fossil Psocoptera so intimately that there can be no doubt that the two groups had a common Protorthopteroid ancestry; and the fact that many Hemiptera have a claval area demarked in their fore wings may possibly indicate that their Protorthopteroid ancestors resembled Protoblattids (in which the claval area is also demarked) in some respects. At any rate, the Hemiptera could not possibly have been derived from such Palæodictyopteroid insects as *Eugereon* (mistakenly called "Protohemiptera"), since *Eugereon* belongs in the section Palæopterygota, whose members are incapable of laying the wings along the body in repose, while the Hemiptera were evidently descended from ancestors capable of laying the wings back along the body in repose, and the venation of primitive Hemiptera does not bear the slightest resemblance to that of *Eugereon*.

Some Parametabola (Hemipteroid insects) parallel the Holometabola remarkably closely in their method of development, and indicate very clearly that complete metamorposis arose through an increasing divergence between the immature and mature forms (rather than through the precocious emergence of "free-living embryos", as certain investigators insist is the case) as the result of mutational changes in the genetic or hereditary material of these insects. Thus in larval Aleurodidæ, for example, the wings arise internally from wing buds, and become external in a quiescent pupal stage,[1] as they do in the Holometabola; and the development of certain Thysanoptera and other Hemipteroid insects clearly suggests the beginning of Holometabolism.

In this connection, it may be noted that the internal development of the wings in the Aleurodidæ, and the external development of the wings in the closely related Psyllidæ and other Hemiptera-Homoptera, clearly indicates that the usual division of winged insects into Exopterygota and Endopterygota, on the basis of the external or internal development of the wings, is utterly meaningless from the standpoint of phylogeny. Such a division would group together the remotely related Palæodictyopteroid, Orthopteroid and Hemipteroid insects, and would separate the Holometabola from their Orthopteroid relatives, etc.; and this division of winged insects should be abandoned in favor of the more natural and fundamental grouping of winged insects into Palæopterygota and Neopterygota (on the basis of the method of folding the wings in repose), since this grouping does not separate the Holometabola from their Hemipteroid and Orthopteroid relatives.

The section Holometabola (or Neuropteradelphia) includes all insects with complete metamorphosis, and the group is evidently a monophyletic one since their larvæ intergrade so intimately that all of the Holometabola must have had a common ancestry. The fact that some Holometabola are somewhat Psocid-like, and the fact that some Psocoid (or Hemipteroid) insects, such as the Aleurodidæ, etc., clearly foreshadow Holometabolism, would seem to indicate that both Parametabola (Hemipteroids) and Holometabola were descended from closely allied Protorthoptera —which may have resembled the Protoblattids venationally, although their bodies probably exhibited features occurring in the ancestral Isoptera, Embiids and Grylloblattids.

The most primitive representatives of the Holometabola are the Neuroptera, Hymenoptera and Coleoptera, and their complicated interrelationships (both "vertical" and "horizontal" in the phylogenetic groupings) make it very difficult to decide how to distribute them in the superorders of the Holometabola. There are at least two superorders of Holometabola, in one of which, the Pancoleoptera or Coleopteria (including the Coleoptera and Strepsiptera), the mesothoracic coxae are not divided into eucoxa and meron, the mesothoracic postscutellum is not well developed, and the cerci are usually not developed, while in the other superorder called the Panneuroptera or Neuropteria (including the Neuroptera, Mecoptera, Diptera, Trichoptera, Lepidoptera and Siphonaptera) the mesothoracic coxae are divided into a eucoxa and meron, the mesothoracic postscutellum is usually well developed, and cerci are frequently present.

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[1] A quiescent pupal stage is also foreshadowed in the Isoptera.

The Coleoptera are the most Orthopteroid representatives of the Holometabola, and are strikingly similar to the Dermaptera in numerous features of the body. It is possible that the Coleoptera and Dermaptera were derived from Protorthopteroid ancestors which had bodies somewhat like those of the primitive Isoptera, while the wings of their ancestors may have been like those of certain Protoblattid Protorthoptera. At any rate, the wings of the so-called Protocoleoptera (such as *Protocoleus*) are very Orthopteroid, and may have been derived from a Protorthopteroid type related to the Protoblattids.

The most primitive Coleoptera are the Cantharoid (Lampyroid) beetles, and the Strepsiptera may have been derived from ancestors resembling Cantharoid beetles in some respects. The larvæ of the Strepsiptera are very Meloid in appearance, while the adult Strepsiptera resemble Rhipiphorid beetles in some respects, so that it is very probable that the Strepsiptera were derived from a Coleopteroid stock, although the exact character of their ancestors has not been determined.

The Neuroptera have retained the most primitive type of venation occurring in any Holometabola (with the possible exception of the Mecoptera), and the structures of the body of the primitive Sialid Neuroptera suggest that their ancestors had bodies resembling those of primitive Isoptera and Embiids in many respects, while the venation of the

Corydalid Neuroptera is rather suggestive of that of certain Protoblattid Protorthoptera. The venation of the Protorthopteroid insect *Metropator* (which is regarded as a "Palæodictyopteroid" insect by Handlirsch) exhibits certain features suggestive of the precursors of the Sialid type of venation, but *Metropator* is an oligoneurous form (with few veins) and it is hardly probable that the more richly veined (polyneurous) types of Neuroptera, especially the fossil forms, were derived from the oligoneurous *Metropator* type of Protorthopteroid insect. In fact, it is very probable that the Protorthopteroid ancestors of the Neuroptera were both oligoneurous and polyneurous, and both tendencies would naturally reappear in their Neuropterous descendents if both tendencies occurred in the ancestral stock. Some investigators consider that the venation of the Neuroptera indicates that they were derived from Palæodictyoptera, but the Neuroptera are clearly Neopterygota capable of laying the wings back along the body in repose, and their larvae intergrade extremely closely with those of the Coleoptera, clearly indicating that the Neuroptera were derived from the same Protorthopteroid ancestors as the Coleoptera, and the venation of the primitive Neuroptera might readily be derived from the type exhibited by certain Protoblattid Protorthoptera.

The Mecoptera are extremely closely related to the Neuroptera, and were evidently derived from the same Protorthopteroid ancestors from which the Neuroptera were descended. The venation of the primitive Mecoptera suggests that their ancestors were similar to the Protoblattid Protorthoptera in certain respects, although Tillyard considers that the Mecoptera were derived from ancestors of the *Metropator* type, and Tillyard likewise considers that the Mecoptera are more primitive than the Neuroptera. The head and mouthparts of the Mecoptera are more specialized than those of the Sialid Neuroptera, however, and the thoracic sclerites of the Neuroptera are of a much more primitive type than those of the Mecoptera, while some Neuroptera such as *Raphidia* have retained an Orthopteroid ovipositor which is lost in typical Mecoptera, so that the Neuroptera are more primitive, in general, than the Mecoptera are, and have departed less than the Mecoptera have, from the ancestral Holometabolous stock, which was probably a Protorthopteran type with body structures like those of primitive Isoptera and Embiids, and with a venation resembling that of certain Protoblattids. Handlirsch would derive the Mecoptera from Megasecoptera, but the Megasecoptera belong in the section Palæopterygota, whose members are incapable of laying the wings back along the body in repose, while the Mecoptera are clearly Neopterygota capable of laying the wings back along the body in repose, and the resemblance between the venation of certain Mecoptera and Megasecoptera is apparently the result of convergence.

The Diptera were undoubtedly descended from Mecoptera-like forebears, as is evidenced by all of their structural features; and fossils such as *Aristopsyche* (called Paratrichoptera or Protodiptera), which have a venation strikingly suggestive of the ancestors of the Diptera, merge so indistinguishably with the Mecoptera, that it is very doubtful that they are worthy of ordinal rank, and it is preferable to group them with the Mecoptera as a suborder of Mecoptera. Among the living Mecoptera, such forms as *Nannochorista* have preserved numerous features suggestive of the ancestors of the Diptera,[2] and clearly indicate that the labella of Diptera, for example, are merely modified segments of the labial palpi.

The Trichoptera have likewise preserved a great number of characters strikingly suggestive of the precursors of the Diptera, but the Trichoptera are more closely allied to the Lepidoptera than any other insects. In fact, the Rhyacophilid Trichoptera merge so indistinguishably with the Micropterygid Lepidoptera that it is very doubtful if the two groups are worthy of ordinal rank, although it is preferable to treat them as distinct orders for the sake of convenience. Fossils such as *Belmontia* (usually placed in a distinct order the Paramecoptera or Prototrichoptera) are strikingly suggestive of the common ancestors of the Trichoptera and Lepidoptera and lead back to ancestors resembling the fossil Mecoptera. The venation of *Belmontia* is so like that of certain Rhyacophilid Trichoptera that the differences hardly seem to be of ordinal value. At any rate, the Trichoptera have departed the least of any living insects from the ancestors of the Lepidoptera, and the Mecoptera are the nearest living representatives of the forms ancestral to the Trichoptera.

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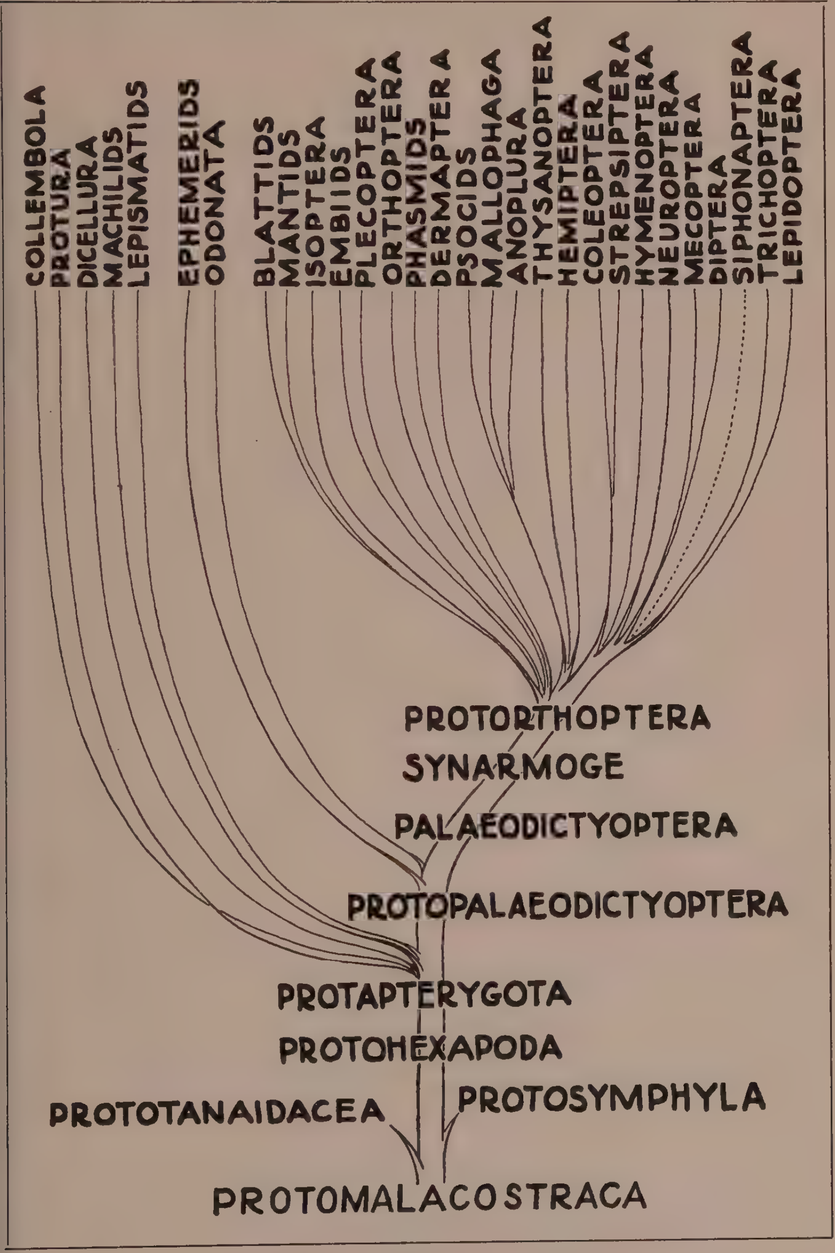
[2] The Tanyderidae and Trichoceridae are the most primitive living Diptera, and the Anisopodidae are very like the ancestors of the Brachycera, whose most primitive representatives are the Therevidae and Rhagionidae (Leptidae), while the Syrphidae have departed but little from the ancestors of the Cyclorrhapha.

The origin and closest affinities of the Siphonaptera, or fleas, is still a subject of much dispute, and it is impossible to decide the question in the present state of our knowledge of the group. It is quite evident, however, that the Siphonaptera resemble both Diptera and Trichoptera in numerous features of their larval and adult anatomy, and this probably indicates that the fleas were descended from the common ancestors of the Diptera and Trichoptera. Since the Mecoptera are the nearest living representatives of the common ancestors of the Diptera and Trichoptera, the fleas were doubtless derived from Mecopteroid ancestors as yet unknown.

The Hymenoptera combine in themselves so many characters occurring in both the Coleopteroid and the Mecopteroid insects that it is very difficult to determine their closest affinities, although they have a greater number of characters in common with the Mecopteroid insects than with any other group, and their larvae (particularly those of the sawflies) are strikingly similar to larval Mecoptera, Lepidoptera, etc. These facts may be interpreted as indicating that the Hymenoptera should be grouped with the Mecopteroid insects in the superorder Panneuroptera (Neuropteria), but since the Hymenoptera are in many respects intermediate between the Coleopteroid and Mecopteroid insects their annectant character may be better indicated by placing them in a distinct superorder, the Panhymenoptera (or Hymenopteria), occupying a position intermediate between the Mecopteroid insects (Panneuroptera) and Coleopteroid insects (Pancoleoptera), and characterized by the occurrence of an ovipositor (represented by a saw or a sting), forcipate male genitalia, cerci, an Orthopteroid head, etc., and by the absence of the meron in the mesothoracic coxæ.

Tillyard considers that the Hymenoptera were derived from the so-called "Protohymenoptera", which have been shown by Carpenter to be merely modified Megasecoptera, having nothing to do with the true ancestors of the Hymenoptera. The Megasecoptera belong in the division Palæopterygota, whose members are incapable of laying the wings back along the body in repose, while the Hymenoptera were evidently descended from ancestors which were capable of laying the wings back along the abdomen in repose. Their ancestors apparently were Protorthoptera with bodies like those of primitive Isoptera and Embiids, while the venation was probably like that of certain Protoblattids. In other words, the Hymenoptera were descended from a common ancestry with the Sialid Neuroptera (and the Lampyroid Coleoptera), and their line of descent also merges with that of the Mecoptera and Trichoptera, or branches off from the common stem near the point of origin of the lines of descent of the Mecopteroid insects. The most primitive living representatives of the Hymenoptera are the Xyelidæ, and the Cephidæ are the nearest representatives of the ancestors of the higher Hymenoptera (or Clistogastra), whose most primitive representatives are the Trigonalidæ.

The views briefly summarized above, have already been presented in a series of papers dealing with the comparative morphology of recent insects in the light of what is known of the fossil forms, but since these views differ very radically from those commonly accepted by recent writers, or by those who have reviewed the recent progress in insect phylogeny, they have not been taken into consideration by recent writers. When a more extensive study of the available evidence is made, however, it becomes readily apparent that many of the currently accepted views are quite untenable; and the foregoing brief summary of certain alternative views on the subject has been made in order to call attention to the fact that the currently accepted views concerning the origin and interrelationships of the insectan orders are not the only possible ones, or necessarily the correct ones, and some consideration should also be given to these alternative views if they are evidently more nearly in accord with the available evidence on the subject.



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